(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 January 2002 (10.01.2002)

PCT

(10) International Publication Number
WO 02/03717 A2

(51) International Patent Classification[7]: H04Q 7/00

(21) International Application Number: PCT/SE01/01571

(22) International Filing Date: 5 July 2001 (05.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/610,169 5 July 2000 (05.07.2000) US

(71) Applicant: TELEFONAKTIEBOLAGET L M ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventor: SAWYER, Francois; 1895 Me Gantic, St. Hubert, Quebec J3Y 7H7 (CA).

(74) Agent: MAGNUSSON, Monica; Ericsson Radio Systems AB, Patent Unit Radio Acces, S-164 80 Stockholm (SE).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 02/03717 A2

(54) Title: ALLOCATED FREQUENCY SPECTRUM SHARING BETWEEN WIDEBAND AND NARROWBAND RADIO ACCESS TECHNOLOGIES

(57) Abstract: A given allocated contiguous frequency spectrum (for uplink or downlink) is shared by a wireless cellular communications system between a wideband communications portion and a narrowband communications portion. The wideband portion utilizes at least one wideband carrier, and the narrowband portion utilizes a plurality of narrowband carriers. When implemented, the narrowband portion is assigned to both higher power transmission macro-cells and lower power transmission micro- or pico-cells. In this assignment, the plurality of narrowband carriers are assigned to the first and second type cells in a manner where the narrowband carriers located adjacent in the allocated frequency spectrum to the wideband carrier are reserved for assignment only to the lower transmission cells.

ALLOCATED FREQUENCY SPECTRUM SHARING BETWEEN WIDEBAND AND NARROWBAND RADIO ACCESS TECHNOLOGIES

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to wireless communications systems and, in particular, to the sharing of an allocated contiguous frequency spectrum between complementary radio access technologies offered by an operator.

Description of Related Art

A cellular operator is allocated a certain frequency spectrum for use in providing its cellular service. Such service may be provided through any one of a number of a available narrowband radio access technologies. Examples of such narrowband radio access technologies include several types of multiple access technologies (like the advanced mobile phone service (AMPS), the digital advanced mobile phone service (D-AMPS, TIA IS-136), the personal communications service (PCS), the global system for mobile (GSM) communications service, enhanced data rates for global evolution (EDGE), code division multiple access (CDMA, TIA IS-95) service, and the like). FIGURE 1 shows an exemplary frequency allocation (uplink or downlink) for a narrowband radio access technology comprising an allocated contiguous frequency spectrum 10 (15 MHz wide in GSM, for example) divided into a plurality of carriers 12 (200 KHz each wide in GSM, for example). In FIGURE 1, the y-axis measures transmitted power (P) and the x-axis measures frequency (f).

A problem with these existing narrowband radio access technologies is that the narrowband carriers 12 and the associated air interface specification (for example, IS-54B, IS-136, IS-95, GSM, and the like) defining their use are not well suited (as currently implemented) for handling high data rate cellular services. By this it is meant that they cannot provide what is becoming known in the industry as third-generation (3G) cellular services like web browsing, file transfer, video conferencing,

and the like, at data rates on the order of 384 Kbps. To provide such services, the operator may take a portion of its allocated contiguous spectrum away from providing narrowband services and instead utilize it to provide 3G cellular services through an appropriate wideband radio access technology (for example, CDMA; wideband CDMA (W-CDMA), CDMA2000, and the like). FIGURE 2 shows an exemplary frequency allocation for a shared wideband/narrowband radio access technology comprising an allocated contiguous frequency spectrum 10 (15 MHz wide, for example) used for uplink or downlink that is divided into a first portion 14 (for example, 10 MHz wide in total) reserved for narrowband radio access technology use, with the portion including a plurality of carriers 12 (200 KHz each wide in GSM, for example), along with a second portion 16 (for example, 5 MHz wide) reserved for wideband radio access technology using a single wideband carrier 18 (5 MHz wide in W-CDMA). Again, in FIGURE 2 the y-axis measures transmitted power and the x-axis measures frequency.

It is now assumed, as is typically the case, that transceivers with similar broadcast power characteristics (such as a twenty watt transceiver) are used for each narrowband carrier 12 and the single wideband carrier 18. When the same transmit power is spread over a wider channel (5 MHz versus 200 KHz), the amount of energy per hertz (i.e., the spectral density) for the wideband carrier 18 is lower than that for each of the narrowband carriers 12. This is illustrated in FIGURE 2 with respect to the measured power amplitude difference between the carriers 12 and 18.

Reference is now made to FIGURE 3 wherein there is shown a representative spectrum mask for a single narrowband or wideband carrier 12 or 18, respectively. It is well known that even through a carrier has a designed nominal power level 20 and a designed nominal bandwidth 22 (for example, 200 KHz in GSM and EDGE, 5 MHz in W-CDMA, 30 KHz for AMPS and D-AMPS, or 1.25 MHz for CDMA), in reality the transmitter and receivers are not perfect, and thus the transmitter will broadcast, and the receiver will receive, at frequencies outside of the nominal bandwidth 22 (as

generally indicated at 24), such as, for example, at power levels 26 that are approximately 30dB below the nominal power level 20.

Referring once again to FIGURE 2, it is recognized that at lower power levels 26, with respect to both the narrowband carriers 12 and the wideband carrier 18, the transceivers transmit and receive in a wider spectrum (see, generally, at 30) than at the nominal power level 20 (see, generally, at 32). Given that the narrowband radio access technology will have a much higher spectral density, and further given the nature of the spectral mask of FIGURE 3, the leakage outside of the nominal bandwidth 22 for a narrowband carrier 12 will have a higher power level relative to the wideband carrier 18. At the point or points within the allocated frequency spectrum 10 where a narrowband carrier 12 lies adjacent the wideband carrier 18 (see, generally, at 34), and even if the bandwidth spill-over 24 (FIGURE 3) complies with the radio access technology specification, a significant danger exists that transmissions with respect to the narrowband carrier will interfere with the transmissions for the wideband carrier.

Reference is now made to FIGURE 4 wherein there is shown an exemplary modified frequency allocation for a shared wideband/narrowband radio access technology. To address this concern over interference, the operator typically includes, at the expense of losing use of one or more otherwise available narrowband carriers 12 (generally shown in dashed lines), a guard band 36 between the second (wideband) portion 16 and each adjacent first (narrowband) portion 14. At the current auction cost for wireless communications spectrum, however, this loss of otherwise available carriers 12 for operator use is unacceptable. There is accordingly a need for a improved frequency allocation for use in a shared wideband/narrowband radio system having a minimal guard band allowing for maximum use of potentially available carriers.

SUMMARY OF THE INVENTION

A wireless cellular communications system implements a wideband communications portion (that utilizes at least one wideband carrier) positioned adjacent to a narrowband communications portion (that utilizes a plurality of narrowband carriers) within a given allocated frequency spectrum for communications. The narrowband communication portion of the wireless cellular communications system includes both higher power transmission first type cells (like macro-cells) and lower power transmission second type cells (like micro-cells and pico-cells). A frequency allocation for the wireless communications system assigns the plurality of narrowband carriers to the first and second type cells in a manner provided that those ones of narrowband carriers located adjacent in allocated frequency spectrum to the wideband carrier are reserved for assignment only to the lower power second type cells.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be acquired by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1 (previously described) illustrates an exemplary frequency allocation for a narrowband radio access technology;

FIGURE 2 (previously described) illustrates an exemplary frequency allocation for a shared wideband/narrowband radio access technology without guard bands;

FIGURE 3 (previously described) illustrates a representative spectrum mask for a narrowband or wideband carrier;

FIGURE 4 (previously described) illustrates an exemplary modified frequency allocation for a shared wideband/narrowband radio access technology with guard bands;

FIGURE 5 illustrates a cell coverage plan for a conventional narrowband radio access technology cellular system; and

FIGURE 6 illustrates a frequency allocation for a shared wideband/narrowband radio access technology in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIGURE 5 wherein there is illustrated a cell coverage plan for a conventional narrowband radio access technology cellular system. For a given service area 50, an operator may divide the area for ubiquitous communications coverage using a plurality of macro-cells 52 (each having, for example, a coverage radius of between three and twenty kilometers). A base station 54 for each macro-cell 52 includes transceivers (not shown) that utilize several of the narrowband carriers 12 (see, for example, FIGURE 1) to support wireless communications with proximately located mobile stations 56. The carriers 12 are distributed among and between the cells 52 in a well known manner to maximize capacity and minimize interference in accordance with a specified frequency reuse plan.

In high density networks (such as those in cities), the operator may further choose to deploy lower power micro-cells 60 and pico-cells 62 in order to provide greater capacity at certain hot spots like central business districts, airports, train stations, shopping centers, indoor office environments, and the like. The micro cells 60 may each have, for example, a coverage radius of less than one kilometer, while the pico cells 62 may each have, for example, a coverage radius of less than one-hundred meters. Like the macro-cells, a base station 66 is provided for each micro-cell 60 and pico-cell 62 that includes transceivers (not shown) that utilize one or more of the narrowband carriers 12 (see, for example, FIGURE 1) to support wireless communications with proximately located mobile stations 56. In the context of the micro-cells 60 and pico-cells 62, the carriers 12 similarly may be distributed to

maximize capacity and minimize interference in accordance with a specified frequency reuse plan (that is not necessarily the same as that used by the macro-cells).

To support 3G cellular services, the operator may also utilize the transceivers for the macro-cell 52 base stations 54 to utilize a wideband carrier 18 (see, for example, FIGURE 2) to support wireless communications with proximately located mobile stations 56. The carriers 18 are distributed among and between the cells 52 in a well known manner to maximize capacity and minimize interference in accordance with a specified frequency reuse plan.

Reference is now made to FIGURE 6 wherein there is illustrated a frequency allocation for a shared wideband/narrowband radio access technology in accordance with the present invention. An allocated contiguous frequency spectrum 10 (15 MHz wide, for example) is divided into a first portion 14 (for example, 10 MHz wide in total) reserved for narrowband radio access technology use, with the portion including a plurality of narrowband carriers 12 (200 KHz each wide in GSM, for example), along with a second portion 16 (for example, 5 MHz wide) reserved for wideband radio access technology using a single wideband carrier 18 (5 MHz wide in W-CDMA). Although illustrated with the wideband portion 16 placed between a split narrowband portion 14, it will be understood that this implementation is exemplary in nature and that other divisions of the spectrum 10 may be used. It is further understood that the illustration in FIGURE 6 represents allocated spectrum 10 for either uplink or downlink communications. In FIGURE 6, the y-axis measures transmitted power and the x-axis measures frequency. For purposes of this application and the claims herein, the term “narrowband” and “wideband” in the context of a carrier refer to technologies wherein the bandwidth of the wideband carrier is nominally 3-5 times that of the narrowband carrier that is also being implemented by the operator within the same shared frequency spectrum. In the context of the present invention, the larger the ratio between the wideband and narrowband carrier, the more

effective the results obtained from assigning micro- or pico-cells to carriers adjacent the wideband carrier.

Recognizing that the transceivers (base stations) for the micro-cells 60 and pico-cells 62 utilize a lower power transmission than the macro-cells 52, the frequency allocation of the present invention advantageously assigns the narrowband carrier 12 or carriers (referred to as carriers 12') adjacent the wideband carrier 18 for use by those micro-cells and pico-cells (see, implementation in FIGURE 5). In this configuration, the bandwidth spill-over 24 for those micro-cell and pico-cell reserved narrowband carriers 12' is much less likely to interfere with the transmissions for the wideband carrier 18 (which is also a relatively lower spectral density than the macro-cell assigned carriers 12). This allows the previously unusable adjacent narrowband carriers 12 (see, dotted lines in FIGURE 4) to be used as narrower guard bands 36' will provide sufficient insulation from interference between the adjacent lower power signals.

Although preferred embodiments of the method and apparatus of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

WHAT IS CLAIMED IS:

1. A cellular communications system provided by an operator that has been allocated a certain frequency spectrum, comprising:

a plurality of higher power transmission cells; and

a plurality of lower power transmission cells;

wherein the allocated frequency spectrum is divided into a first portion including a plurality of narrowband carriers for providing narrowband radio access and a second portion including at least one wideband carrier for providing wideband radio access; and

wherein the plurality of narrowband carriers are assigned to the plurality of higher power and lower power transmission cells in a manner such that any ones of the narrowband carriers located adjacent in the allocated frequency spectrum to the wideband carrier are assigned to the lower power transmission cells.

2. The system of claim 1 wherein the higher power transmission cells comprise macro-cells and the lower power transmission cells comprise micro-cells.

3. The system of claim 1 wherein the higher power transmission cells comprise macro-cells and the lower power transmission cells comprise pico-cells.

4. The system of claim 1 wherein the narrowband radio access is provided through an access technology selected from the group consisting of:

AMPS;

D-AMPS;

GSM;

PCS;

EDGE; and

CDMA.

5. The system of claim 4 wherein the wideband radio access is provided through an access technology selected from the group consisting of:

CDMA;

W-CDMA; and

CDMA2000.

6. The system of claim 1 wherein the certain frequency spectrum is contiguous.

7. A method for assigning carriers from an allocated radio frequency spectrum to cells in a wireless cellular communications system including both higher power transmission cells and lower power transmission cells, comprising the steps of:

dividing the allocated radio frequency spectrum into a first portion including a plurality of narrowband carriers for providing narrowband radio access and a second portion including at least one wideband carrier for providing wideband radio access;

assigning the plurality of narrowband carriers to the plurality of higher power and lower power transmission cells in a manner such that any ones of the narrowband carriers located adjacent in the allocated frequency spectrum to the wideband carrier are assigned to the lower power transmission cells.

8. The method of claim 7 wherein the higher power transmission cells comprise macro-cells and the lower power transmission cells comprise micro-cells.

9. The method of claim 7 wherein the higher power transmission cells comprise macro-cells and the lower power transmission cells comprise pico-cells.

10. The method of claim 7 wherein the narrowband radio access is provided through an access technology selected from the group consisting of:

AMPS;

D-AMPS;

GSM;

PCS;

EDGE; and

CDMA.

11. The method of claim 10 wherein the wideband radio access is provided through an access technology selected from the group consisting of:

CDMA;

W-CDMA; and

CDMA2000.

12. The allocation of claim 7 wherein the allocated radio frequency spectrum is contiguous.

13. A frequency spectrum allocation for a wireless cellular communications system including a plurality of higher power cells and a plurality of lower power cells, comprising:

a first portion of the frequency spectrum for wideband radio access including at least one wideband carrier for providing wideband radio access; and

a second portion of the frequency spectrum for narrowband radio access including a plurality of narrowband carriers for providing narrowband radio access, the plurality of narrowband carriers being assigned to both the higher power and lower power transmission cells in a manner such that any ones of the narrowband carriers located adjacent in the allocated frequency spectrum to the wideband carrier are assigned to the lower power transmission cells.

14. The allocation of claim 13 wherein the higher power transmission cells comprise macro-cells and the lower power transmission cells comprise micro-cells.

15. The allocation of claim 13 wherein the higher power transmission cells comprise macro-cells and the lower power transmission cells comprise pico-cells.

16. The allocation of claim 13 wherein the narrowband radio access is provided through an access technology selected from the group consisting of:

AMPS;

D-AMPS;

GSM;

PCS;

EDGE; and

CDMA.

17. The allocation of claim 16 wherein the wideband radio access is provided through an access technology selected from the group consisting of:

CDMA;

W-CDMA; and

CDMA2000.

18. The allocation of claim 13 wherein the frequency spectrum that is allocated is contiguous.

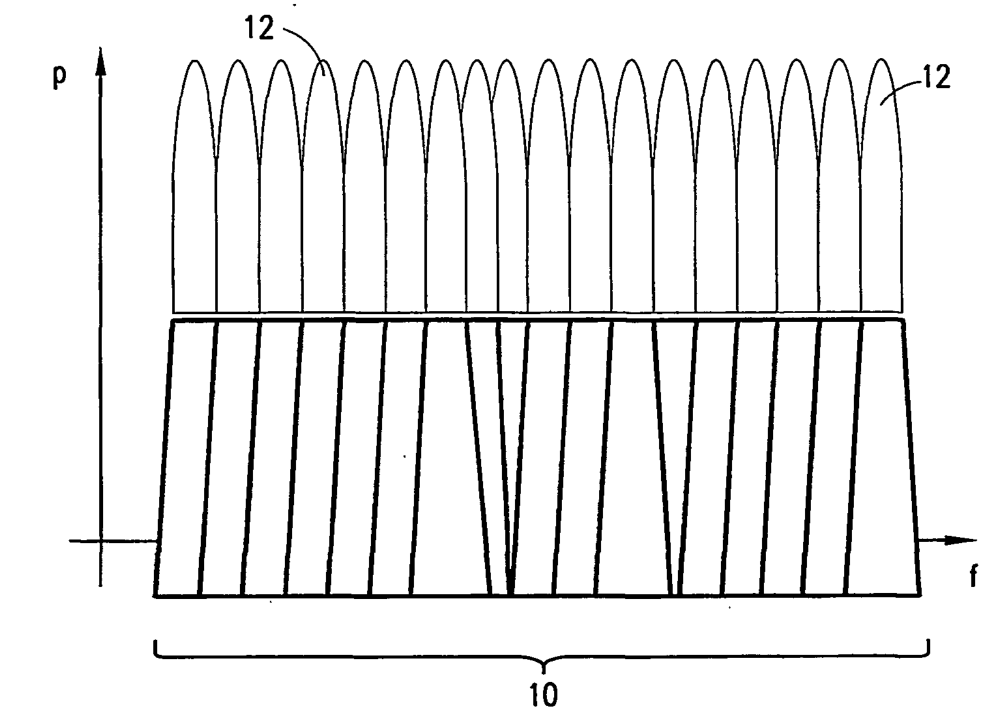

FIG. 1
(PRIOR ART)

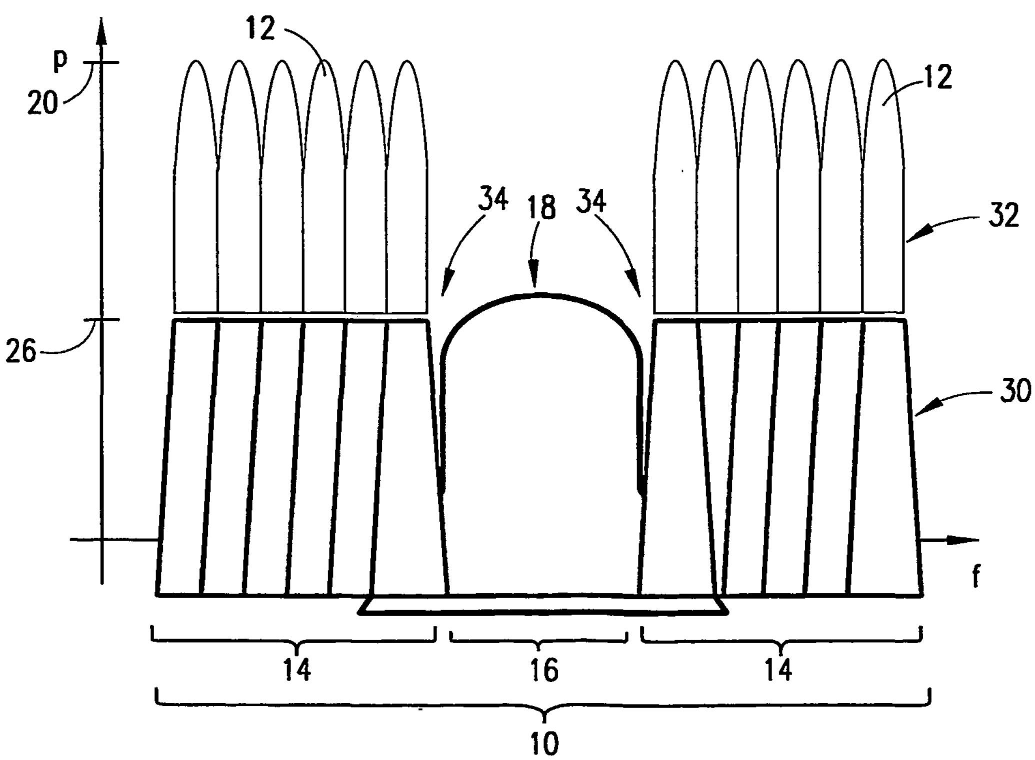

FIG. 2
(PRIOR ART)

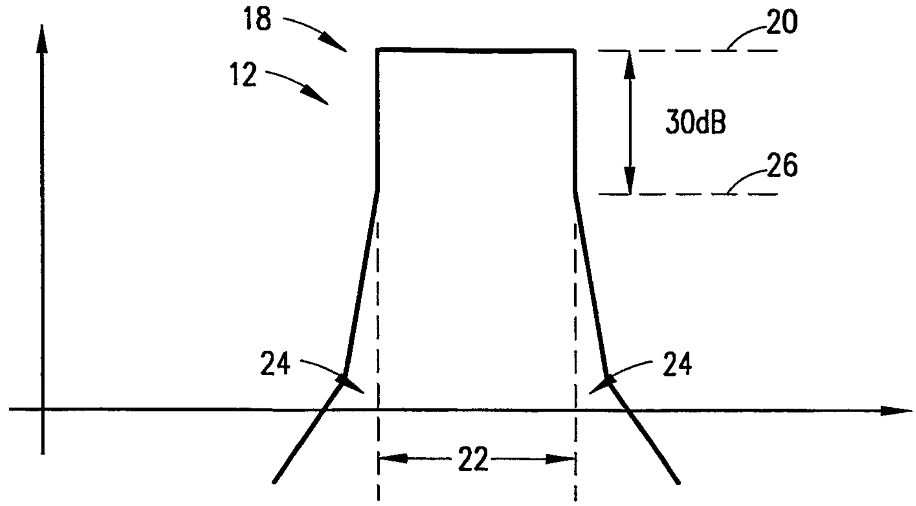

FIG. 3
(PRIOR ART)

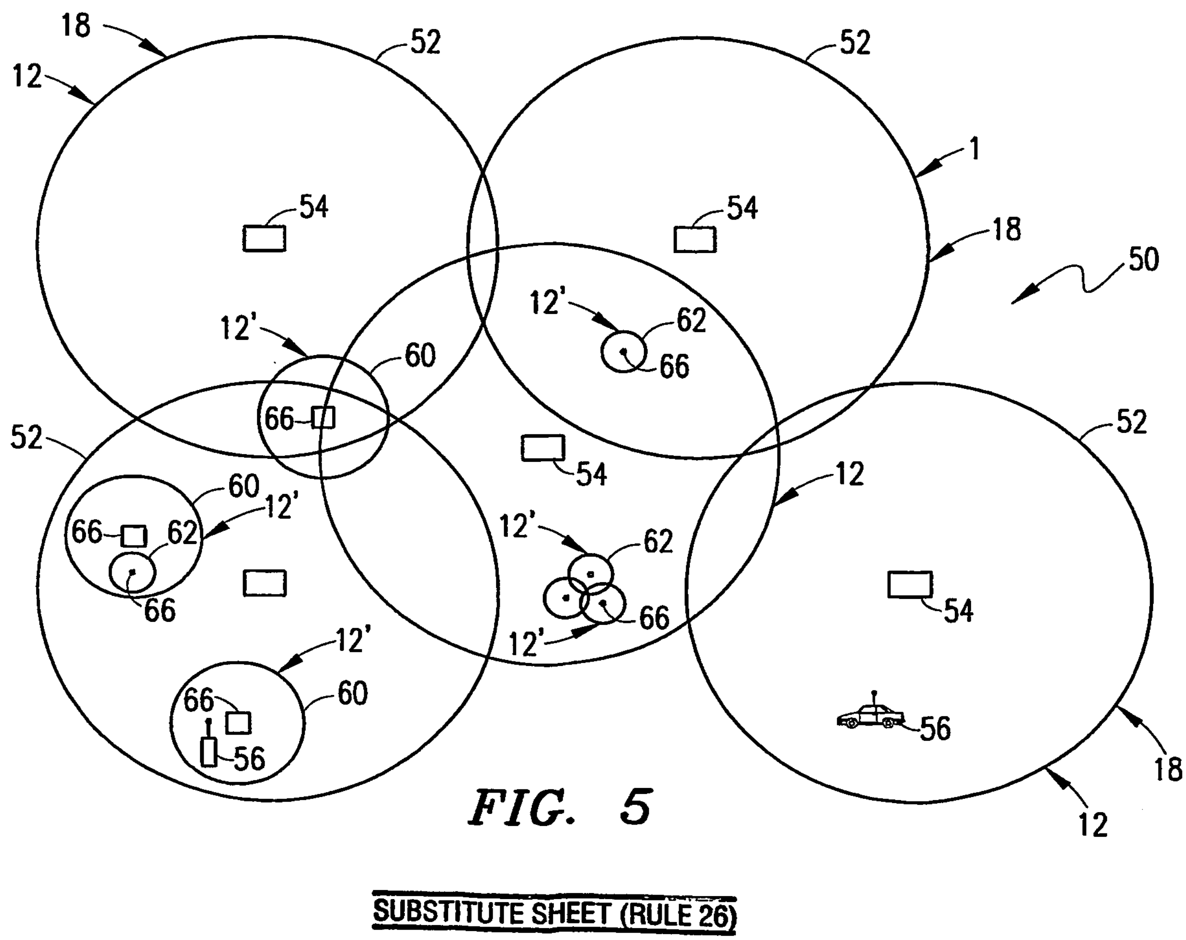

FIG. 5

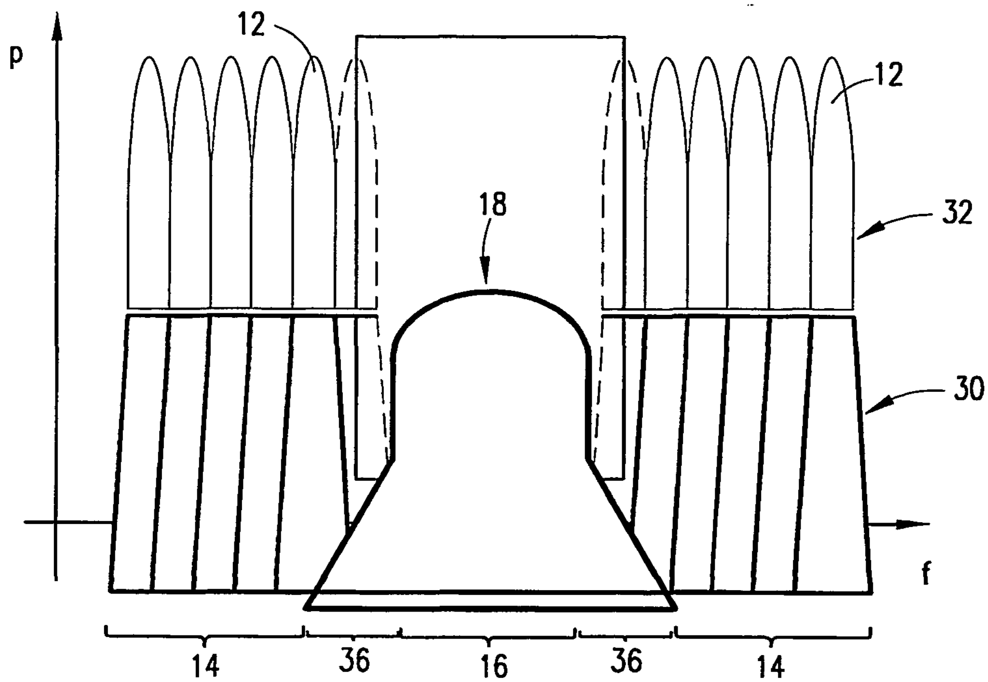

FIG. 4
(PRIOR ART)

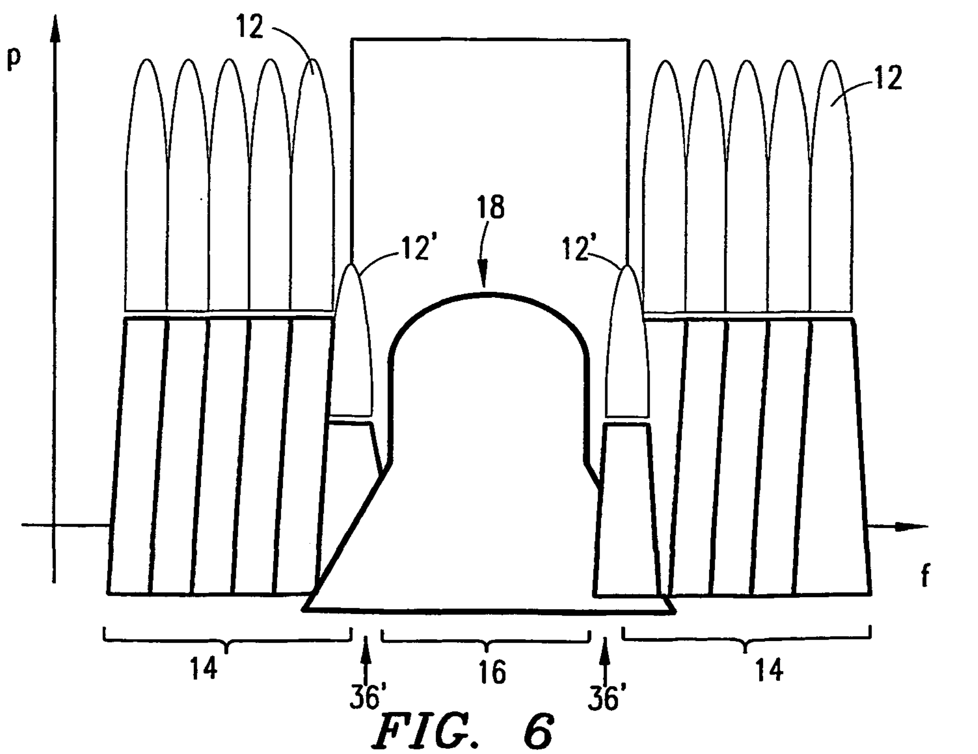

FIG. 6

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
10 January 2002 (10.01.2002)

PCT

(10) International Publication Number
WO 02/03717 A3

(51) International Patent Classification[7]: H04Q 7/36

(21) International Application Number: PCT/SE01/01571

(22) International Filing Date: 5 July 2001 (05.07.2001)

(25) Filing Language: English

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(72) Inventor: SAWYER, Francois; 1895 Me Gantic, St. Hubert, Quebec J3Y 7H7 (CA).

(74) Agent: BEAUCHESNE, Sandra; Ericsson Canada Inc., LMC/UP, 8400 Decarie Boulevard, Town Mount Royal, Montreal, Quebec H4P 2N2 (CA).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report: 20 June 2002

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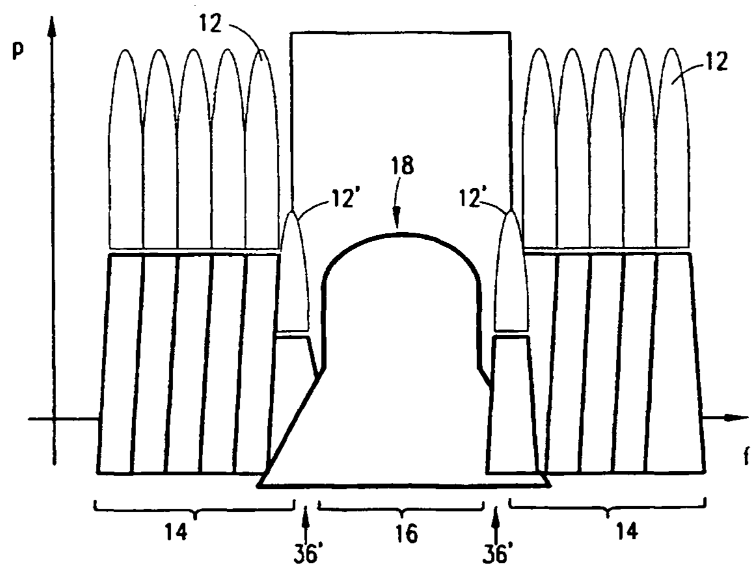

(57) Abstract: A given allocated contiguous frequency spectrum (for uplink or downlink) is shared by a wireless cellular communications system between a wideband communications portion and a narrowband communications portion. The wideband portion utilizes at least one wideband carrier, and the narrowband portion utilizes a plurality of narrowband carriers. When implemented, the narrowband portion is assigned to both higher power transmission macro-cells and lower power transmission micro- or pico-cells. In this assignment, the plurality of narrowband carriers are assigned to the first and second type cells in a manner where the narrowband carriers located adjacent in the allocated frequency spectrum to the wideband carrier are reserved for assignment only to the lower transmission cells.

WO 02/03717 A3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 01/01571

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04B H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 January 2002	29. 01. 2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Nils Nordin

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INTERNATIONAL SEARCH REPORT

·rmation on patent family members

International Application No
PCT/SE 01/01571

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